CVP-2015-00019
Rev. 0

Cleanup Verification Package for the 600-326, Odorous Black Material Waste Site

Prepared for the U.S. Department of Energy
by Washington Closure Hanford

January 2016

EXECUTIVE SUMMARY

This cleanup verification package documents completion of remedial action for the 600-326, Odorous Black Material waste site. The 600-326 waste site is located in the 100-IU-6 Operable Unit in the 600 Area of the Hanford Site in southeastern Washington State. It was identified as a site requiring remediation in the *Record of Decision, Hanford 100 Area Superfund Site, 100-FR-1, 100-FR-2, 100-FR-3, 100-IU-2, and 100-IU-6 Operable Units, Hanford Site, Benton County, Washington* (Final Action ROD) (EPA 2014).

The 600-326, Odorous Black Material waste site is described as two distinct areas that contained black material with a hydrogen-sulfide odor. The 600-326 waste site was administratively divided into two subsites based on the geographic locations; they consist of the 600-326:1, Odorous Black Material Area 1 subsite and the 600-326:2, Odorous Black Material Area 2 subsite. There is no process history associated with these subsites.

Remediation of the 600-326 waste site was performed on September 29 and 30, 2015. Approximately 30 bank cubic meters (39 bank cubic yards) of excavated materials were removed and loaded for direct disposal at the Environmental Restoration Disposal Facility. The maximum depth of the 600-326:1 subsite excavation was approximately 0.3 m (1 ft) and the maximum depth of the 600-326:2 subsite excavation was 0.45 m (1.5 ft). Excavated materials consisted of black odorous material, underlying soil, and burned insulation. No overburden soil was salvaged from the waste site excavation and no staging pile areas were utilized.

Verification sampling of the 600-326 waste site excavation was performed on October 1, 2015. The results indicated that the waste removal action achieved compliance with the remedial action objectives and cleanup levels for the 600-326 waste site. A summary of the cleanup evaluation for the soil results against the applicable criteria is presented in Table ES-1.

Table ES-1. Summary of Cleanup Verification Results for the 600-326 Waste Site. (2 Pages)

Regulatory Requirement	Cleanup Levels	Results	Remedial Action Objectives Attained?
Direct Exposure – Radionuclides	Attain individual radionuclide CULs and attain radionuclide total excess cancer risk of $<1 \times 10^{-4}$ over 1,000 years or an excess dose of <15 mrem/yr, whichever is lower.	Radionuclides were not COCs for the 600-326 waste site.	NA
Direct Exposure – Nonradionuclides	Attain individual COC direct exposure CULs.	All individual COC concentrations are below the residential direct exposure CULs.	Yes
Nonradionuclide Risk Requirements	Attain a hazard quotient of <1 for all individual noncarcinogenic COCs.	There were no constituents that qualified for the hazard quotient calculation; therefore, the criteria for each individual hazard quotient of <1 is met.	Yes
	Attain a cumulative hazard quotient of <1 for noncarcinogenic COCs.	There were no constituents that qualified for the hazard quotient calculation; therefore, the criteria for the cumulative hazard of <1 is met.	
	Attain an excess cancer risk of $<1 \times 10^{-6}$ (residential land use) for individual carcinogenic COCs.	The excess cancer risk values for individual carcinogenic COCs are $<1 \times 10^{-6}$ (residential land use).	
	Attain a total excess cancer risk of $<1 \times 10^{-5}$ for carcinogenic COCs.	The total excess cancer risk (1.83×10^{-7}) is $<1 \times 10^{-5}$.	
Groundwater/River Protection – Radionuclides	Attain single radionuclide COC groundwater and river protection CULs.	Radionuclides were not COCs for the 600-326 waste site.	NA
	Attain National Primary Drinking Water Standards: 4 mrem/yr (beta/gamma) dose rate to target receptors/organs [a].		
	Meet drinking water MCL for alpha emitters.		
	Meet total uranium drinking water standard of 21.2 pCi/L [b].		

Table ES-1. Summary of Cleanup Verification Results for the 600-326 Waste Site. (2 Pages)

Regulatory Requirement	Cleanup Levels	Results	Remedial Action Objectives Attained?
Groundwater/River Protection – Nonradionuclides	Attain individual nonradionuclide groundwater and river cleanup requirements.	All individual COC concentrations are below soil CULs for the protection of groundwater and the Columbia River.	Yes

[a] "National Primary Drinking Water Regulations" (40 CFR 141).
[b] Based on the isotopic distribution of uranium in the Hanford Site background, the 30 µg/L uranium MCL (40 CFR 141.66) corresponds to 21.2 pCi/L. Concentration-to-activity calculations are documented in *Calculation of Total Uranium Activity Corresponding to a Maximum Contaminant Level for Total Uranium of 30 Micrograms per Liter in Groundwater* (BHI 2001).

CFR = *Code of Federal Regulations*
COC = contaminant of concern
CUL = cleanup level
DOE = U.S. Department of Energy
MCL = maximum contaminant level (drinking water standard)
NA = not applicable

The results of the verification sampling are used to make reclassification decisions for the 600-326 waste site in accordance with the TPA-MP-14 procedure in the *Tri-Party Agreement Handbook Management Procedures* (DOE-RL 2011).

The current site conditions achieve the remedial action objectives and the corresponding cleanup levels established in the *Remedial Design Report/Remedial Action Work Plan Addendum for 100-FR-1, 100-FR-2, 100-IU-2, and 100-IU-6 Soils* (DOE-RL 2014) and the Final Action ROD (EPA 2014).

These results show that residual soil concentrations support future land uses that can be represented (or bounded) by a rural residential scenario. The results also demonstrate that residual contaminant concentrations support unrestricted future use of shallow zone soil (i.e., surface to 4.6 m [15 ft]), and contaminant levels remaining in the soil are protective of groundwater and surface water.

The site meets cleanup standards and has been reclassified as Final Closed Out in accordance with the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1989) and the TPA-MP-14 procedure (DOE-RL 2011). A copy of the standalone waste site reclassification form is included as part of the Executive Summary of this document.

WASTE SITE RECLASSIFICATION FORM

Operable Unit: 100-IU-6 **Control No.:** 2015-083

Waste Site Code(s)/Subsite Code(s): 600-326

Reclassification Category: Interim ☐ Final ☒

Reclassification Status: Closed Out ☒ No Action ☐ Rejected ☐
RCRA Postclosure ☐ Consolidated ☐ None ☐

Approvals Needed: DOE ☒ Ecology ☐ EPA ☒

Description of current waste site condition:

The 600-326, Odorous Black Material waste site, part of the 100-IU-6 Operable Unit, was identified as a waste site requiring remediation in the *Record of Decision for the 100-FR-1, 100-FR-2, 100-FR-3, 100-IU-2, and 100-IU-6 Operable Units Hanford Site, Benton County, Washington (Final Action ROD), U.S. Environmental Protection Agency, Region 10, Seattle, Washington* (EPA 2014). The 600-326 waste site consists of two subsites: 600-326:1, Odorous Black Material Area 1 and 600-326:2, Odorous Black Material Area 2. Both subsites are addressed in this Waste Site Reclassification Form and the Cleanup Verification Package.

Remediation of the 600-326 waste site was performed on September 29 and 30, 2015. Approximately 30 bank cubic meters (39 bank cubic yards) of excavated materials were removed and loaded for direct disposal at the Environmental Restoration Disposal Facility (ERDF). The maximum depth of the 600-326:1 subsite excavation was approximately 0.3 m (1 ft) and the maximum depth of the 600-326:2 subsite excavation was 0.45 m (1.5 ft). The excavated materials consisted of black odorous material, underlying soil, and burned insulation. No overburden soil was salvaged from the waste site excavation and no staging pile areas were utilized.

Verification sampling of the 600-326 waste site excavation was performed on October 1, 2015. The results indicated that the waste removal action achieved compliance with the remedial action objectives (RAOs) and cleanup levels (CULs) for the 600-326 waste site.

The selected remedy involved (1) excavating the site to the extent required to meet specified soil CULs, (2) disposing of contaminated excavation materials at the ERDF in the 200 Area of the Hanford Site, (3) demonstrating through verification sampling that cleanup goals have been achieved, and (4) proposing the site for reclassification as Final Closed Out.

Basis for reclassification:

The 600-326 waste site verification sampling results were evaluated in comparison to the CULs and RAOs from the Final Action ROD (EPA 2014) and the *Remedial Design Report/Remedial Action Work Plan Addendum for 100-FR-1, 100-FR-2, 100-IU-2, and 100-IU-6 Soils*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington (DOE-RL 2014). The results of verification sampling do not preclude any future uses (as bounded by the rural residential scenario) and allow for unrestricted use of shallow zone soils (i.e., surface to 4.6 m [15 ft] deep). The analytical results and rationale presented in the attached cleanup verification package also demonstrate that residual contaminant concentrations meet direct exposure cleanup criteria and are protective of groundwater and surface water. The basis for reclassification is described in detail in the *Cleanup Verification Package for the 600-326, Odorous Black Material Waste Site*.

WASTE SITE RECLASSIFICATION FORM

Operable Unit: 100-IU-6 **Control No.:** 2015-083

Waste Site Code(s)/Subsite Code(s): 600-326

Regulator comments:

Waste Site Controls:

Engineered Controls: ☐ Yes ☒ No Institutional Controls: ☐ Yes ☒ No O&M Requirements: ☐ Yes ☒ No

If any of the Waste Site Controls are checked Yes, specify control requirements including reference to the Record of Decision, TSD Closure Letter, or other relevant documents:

J. P. Neath		12/16/15
DOE Federal Project Director (printed)	Signature	Date
NA		
Ecology Project Manager (printed)	Signature	Date
C. J. Guzzetti		12/16/15
EPA Project Manager (printed)	Signature	Date

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ACRONYMS AND ABBREVIATIONS

BCM	bank cubic meters
BCY	bank cubic yards
COC	contaminant of concern
CUL	cleanup level
CVP	cleanup verification package
DQA	data quality assessment
RAO	remedial action objective
WAC	*Washington Administrative Code*

1.0 INTRODUCTION

This cleanup verification package (CVP) documents that the 600-326, Odorous Black Material waste site was remediated in accordance with the *Record of Decision, Hanford 100 Area Superfund Site, 100-FR-1, 100-FR-2, 100-FR-3, 100-IU-2, and 100-IU-6 Operable Units* (Final Action ROD) (EPA 2014). Remedial action objectives (RAOs) and associated cleanup levels (CULs) for this site are documented in the Final Action ROD and the *Remedial Design Report/Remedial Action Work Plan Addendum for 100-FR-1, 100-FR-2, 100-IU-2, and 100-IU-6 Soils (100 Area RDR/RAWP)*(DOE-RL 2014).

The remedy specified in the Final Action ROD (EPA 2014) and conducted for the 600-326 waste site included excavating the site to the extent required to meet specified soil CULs and disposing of contaminated excavation materials at the Environmental Restoration Disposal Facility in the 200 Area of the Hanford Site. Excavation was driven by RAOs for direct exposure, protection of groundwater, and protection of the surface water.

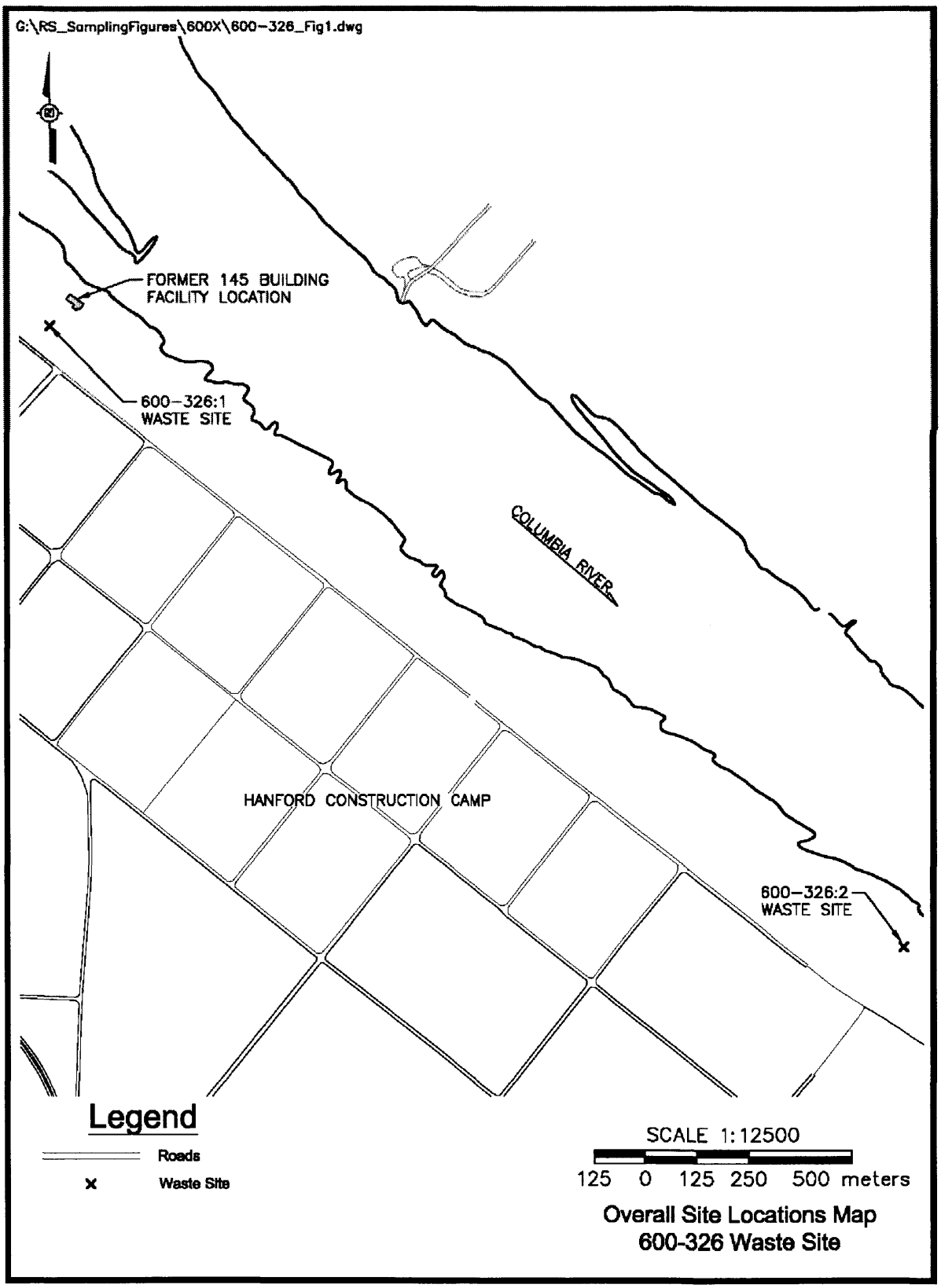
Per the *Work Instruction for Verification Sampling of the Combined 100-IU-2/6 Waste Sites, 600-298, 600-299, 300-300, 600-303, 600-305, 600-306, 600-307, 600-308, 600-309, 600-310, 600-311, 600-312, 600-313, 600-314, 600-316, 600 317, 600-318, 600-319, 600-320, 600-321, 600-324, 600-325, 600-326, 600 328* (WCH 2011), cleanup verification sampling was performed on October 1, 2015, to determine if the 600-326 waste site met RAOs and CULs established by the Final Action ROD (EPA 2014) and the 100 Area RDR/RAWP (DOE-RL 2014). The results indicated that the waste removal action achieved compliance with the RAOs and CULs for the 600-326 waste site.

2.0 SITE DESCRIPTION AND SUPPORTING INFORMATION

2.1 SITE DESCRIPTION

The 600-326, Odorous Black Material waste site is located along the Columbia River in the former Hanford Construction Camp (Figure 1). The 600-326 waste site has been divided into two subsites based on the geographical locations; they consist of the 600-326:1, Odorous Black Material Area 1 and the 600-326:2, Odorous Black Material Area 2. Both subsites are addressed in this CVP as the 600-326 waste site.

Figure 1. The 600-326 Waste Site Location Map.



The 600-326 waste site consisted of two distinct areas that contained black material and included the underlying soil. The black material appeared to be brittle with some angular pieces and had a hydrogen sulfide odor. There is no process history associated with the 600-326 waste site. No structures or waste sites were directly related to this waste site. The material was identified as a potential Foamglas®[1] insulation. The material is also known as cellular glass. This material contains hydrogen sulfide, carbon monoxide, carbon dioxide, glass dust, and crystalline silica.

2.2 HISTORY

Large portions of the areas included in the 100-IU-2 and 100-IU-6 orphan sites evaluation consisted of pre-Manhattan Project farmsteads. These farmstead communities existed from 1880 to 1943. Their locations within the Columbia River corridor are known from historical records. Based on information collected to date, the farmstead remains include small quantities of petroleum materials and hazardous materials identified in the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*.

3.0 REMEDIAL ACTION FIELD ACTIVITIES

3.1 EXCAVATION AND DISPOSAL

Remediation of the 600-326 waste site was performed on September 29 and 30, 2015. The excavated materials consisted of black odorous material, the underlying soil, and burned insulation. The volume of burned insulation excavated from the waste site was less than 1 bank cubic meter (BCM) (1.3 bank cubic yards [BCY]). Approximately 30 BCM (39 BCY) of excavated materials were removed from the 600-326 waste site and loaded for direct disposal at the Environmental Restoration Disposal Facility. The maximum depth of the 600-326:1 subsite excavation was approximately 0.3 m (1 ft) and the maximum depth of the 600-326:2 subsite excavation was 0.45 m (1.5 ft). No overburden soil was salvaged from the waste site excavation and no staging pile areas were utilized. A photograph of each subsite location following remediation is included in Figures 2 and 3.

[1] Foamglas is a registered trademark of Pittsburgh Corning Corporation.

Figure 2. The 600-326:1 Subsite Post-Remediation Photograph (September 2015).

Figure 3. The 600-326:2 Subsite Post-Remediation Photograph (September 2015).

3.2 POST-EXCAVATION WALKAROUND BOUNDARY SURVEY

A walkaround boundary survey was performed on the 600-326 subsite locations following waste site remediation. The 600-326:1 subsite excavation area is approximately 99.8 m^2 (1,074 ft^2) and the 600-326:2 subsite excavation area is approximately 79.8 m^2 (859 ft^2). The area of each excavation was obtained from the walkaround boundary surveys.

4.0 VERIFICATION SAMPLING ACTIVITIES

Cleanup verification sampling was performed at the 600-326 waste site on October 1, 2015, per the *Work Instruction for Verification Sampling of the Combined 100-IU-2/6 Waste Sites, 600-298, 600-299, 300-300, 600-303, 600-305, 600-306, 600-307, 600-308, 600-309, 600-310, 600-311, 600-312, 600-313, 600-314, 600-316, 600-317, 600-318, 600-319, 600-320, 600-321, 600-324, 600-325, 600-326, 600-328* (WCH 2011). Sampling was conducted to support a determination that residual contaminant concentrations in the soil meet cleanup criteria specified in the 100 Area RDR/RAWP (DOE-RL 2014) and the Final Action ROD (EPA 2014).

The following subsections provide additional discussion of the information used to develop the verification sampling design.

4.1 CONTAMINANTS OF CONCERN FOR VERIFICATION SAMPLING

The contaminants of concern (COCs) for the 600-326 waste site were determined based on potential hazardous constituents associated with the odorous gray and porous black material and the confirmatory sampling results (Appendix A). The COCs included polycyclic aromatic hydrocarbons, pesticides, sulfate, and the expanded list of inductively coupled plasma metals.

Because volatile organic compounds and radiological activity were not detected during confirmatory sampling activities, volatile organic compounds and radionuclides were not included as site COCs for verification sampling. No asbestos containing materials were observed at this waste site.

The analytical methods used to evaluate the site COCs are provided in Table 1.

Table 1. The 600-326 – Laboratory Analytical Methods and Contaminants of Concern.

Analytical Method	COCs
ICP metals [a] – EPA Method 6010	Metals
PAH – EPA Method 8310	Polycyclic aromatic hydrocarbons
IC anions [b] – EPA Method 300.0	Fluoride
Pesticides – EPA Method 8081	Pesticides

[a] Analysis was performed for the expanded list of ICP metals and included antimony, arsenic, barium, beryllium, boron, cadmium, chromium (total), cobalt, copper, lead, manganese, molybdenum, nickel, selenium, silver, vanadium, and zinc.
[b] Analyses were performed for the expanded list of IC anions and included bromide, chloride, fluoride, nitrate, nitrite, phosphate, and sulfate.

COC = contaminant of concern
EPA = U.S. Environmental Protection Agency
IC = ion chromatography
ICP = inductively coupled plasma
PAH = polycyclic aromatic hydrocarbons

4.2 VERIFICATION SAMPLING DESIGN SELECTION AND BASIS

This section describes the basis for selection of an appropriate sample design and determination of the number of verification samples that were collected.

4.2.1 Verification Sampling Design

Based on the estimated surface area of 600-326:1 and 600-326:2 subsites in the verification work instruction (WCH 2011) one composite sample was identified for each subsite location for a total of two composite samples for the 600-326 waste site.

4.2.2 Verification Sampling

One focused composite soil sample was collected from each 600-326 subsite location. Additionally, one duplicate soil sample and an equipment blank sample were collected. A summary of the verification samples collected and laboratory analyses performed is provided in Table 2. All sampling was performed in accordance with ENV-1, *Environmental Monitoring & Management*, to fulfill the requirements of the *100 Area Remedial Action Sampling and Analysis Plan* (DOE RL 2009). All samples were submitted to an offsite laboratory for full protocol laboratory analysis.

Table 2. Sample Summary Table for the 600-326 Waste Site. (2 Pages)

Sample Location	HEIS Sample Number	Washington State Plane Coordinates (m) [a]		Sample Analysis
		Northing	Easting	
Area - 1	J1V846	139722.9	585923.9	ICP metals [b], IC anions, PAH, pesticides
Area - 2	J1V847	138200.1	588008.5	
Duplicate of J1V846	J1V848	139722.9	585923.9	

Table 2. Sample Summary Table for the 600-326 Waste Site. (2 Pages)

Sample Location	HEIS Sample Number	Washington State Plane Coordinates (m) [a]		Sample Analysis
		Northing	Easting	
Equipment blank	J1V849	NA	NA	ICP metals [b], mercury

[a] The coordinates provided are the approximate center of the remediated subsite. Composite samples were collected at each location and sample analysis was performed as defined in Table 1, Laboratory Analytical Methods.

[b] The expanded list of ICP metals included antimony, arsenic, barium, beryllium, boron, cadmium, chromium (total), cobalt, copper, lead, manganese, molybdenum, nickel, selenium, silver, vanadium, and zinc in the analytical results package.

HEIS= Hanford Environmental Information System
IC = ion chromatography
ICP = inductively coupled plasma
NA = not applicable
PAH = polycyclic aromatic hydrocarbons

5.0 SAMPLING RESULTS

This section presents the evaluation of the verification sample results for comparison with the data quality criteria and CULs. The verification sample results provided in Appendix B indicate that the waste removal action achieved compliance with the RAOs and CULs for the 600-326 waste site.

5.1 FOCUSED SAMPLE RESULTS

The laboratory-reported verification sample results for all constituents are stored in a Washington Closure Hanford project-specific database prior to archival in the Hanford Environmental Information System and are presented as an attachment to the *600-326 Waste Site Relative Percent Difference (RPD) and Direct Contact Hazard Quotient and Carcinogenic Risk Calculation* (Appendix B).

Comparisons of the results for site COCs with the CULs for 600-326 waste site are listed in Table 3. Analytes that were detected in the samples above soil background levels but that are not considered COCs are reported in Table 4. The additional potential risk contributions associated with the residual concentrations of these non-COC analytes are not significant. Contaminants that were not detected by laboratory analysis are excluded from these tables. Calculated cleanup levels are not presented in the Cleanup Levels and Risk Calculations Database (Ecology 2015) under *Washington Administrative Code* (WAC) 173 340 740(3), "Model Toxics Control Act – Cleanup," for calcium, magnesium, potassium, silicon, and sodium. The *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part A)* (EPA 1989) recommends that aluminum and iron not be considered in site risk evaluations. Therefore, aluminum, calcium, iron, magnesium, potassium, silicon, and sodium are not considered site COCs and are not included in this table.

Table 3. Comparison of Contaminant Concentrations to Cleanup Levels for the 600-326 Composite Verification Samples.

COC	Maximum Result [b, c] (mg/kg)	Soil CULs [a] (mg/kg)		Do the Results Exceed CULs?
		Direct Exposure	Protection of Groundwater and Surface Water	
Arsenic	6.0 (<BG)	20	--	No
Lead	12	250	--	No
Nitrate	2.8 (<BG)	128,260	2,550	No
BAP TEC [d]	0.025	0.14	--	No

[a] CULs obtained from EPA (2014).
[b] Values obtained from Appendix B.
[c] Background values obtained from DOE-RL (2014).
[d] Value is the summed BAP TEC of all detected carcinogenic polycyclic aromatic hydrocarbons (Appendix B).

-- = no CUL/not applicable
BAP = benzo(a)pyrene
BG = background
COC = contaminant of concern
CUL = cleanup level
TEC = toxic equivalency concentration

Contaminants of concern for the 600-326 waste site were selected in the Final Action ROD (EPA 2014). In the event that contaminants are discovered during remediation for which CULs were not established in the Final Action ROD, the information will be presented to the U.S. Department of Energy and EPA project managers for determination of a path forward. While not identified as COCs, total chromium, zinc, phenanthrene and 4,4-DDE were detected in the 600-326 waste site cleanup verification samples. These detections were below risk-based CULs calculated during development of the Final Action ROD (EPA 2014). Therefore, the detected total chromium, zinc, phenanthrene and 4,4-DDE concentrations do not require further discussion.

5.2 DATA QUALITY ASSESSMENT PROCESS

A data quality assessment (DQA) is performed to compare the verification sampling approach and resulting analytical data with the sampling and data quality requirements specified by the project objectives and performance specifications.

The DQA for the 600-326 waste site determined that the data are of the right type, quality, and quantity to support site verification decisions within specified error tolerances. All analytical data were found to be acceptable for decision-making purposes. The evaluation also verified that the sample design was sufficient to support clean site verification. The detailed DQA is presented in Appendix C.

6.0 CLEANUP VERIFICATION DATA EVALUATION

This section demonstrates that contaminant concentrations at the 600-326 waste site achieve the applicable CULs developed to support unrestricted land use at the 100-F/IU Area as established in the Final Action ROD (EPA 2014) and documented in the 100 Area RDR/RAWP (DOE-RL 2014).

6.1 COMPARISON OF SAMPLE DATA TO THE CULS

Table 3 compares the cleanup verification sample results for the 600-326 waste site excavation to the applicable soil CULs for direct exposure, protection of groundwater, and protection of surface water. All COCs were quantified below protection of human health CULs and groundwater and surface water soil CULs.

6.1.1 Attainment of Nonradionuclide Noncarcinogenic and Carcinogenic Risk Standards

Assessment of the risk requirements for the 600-326 waste site was determined by calculation of the hazard quotient and excess carcinogenic risk. The requirements include an individual hazard quotient of less than 1.0, a cumulative hazard quotient of less than 1.0, an individual contaminant carcinogenic risk of less than 1×10^{-6}, and a cumulative excess carcinogenic risk of less than 1×10^{-5}. The hazard quotient and excess carcinogenic risk calculations were conservatively performed using the highest of the focused sample results from all decision units. Risk values were not calculated for constituents that were not detected or were detected at concentrations below Hanford Site or Washington State background values. None of the COC constituents qualified for the hazard quotient calculation; therefore, the hazard quotient values are zero, which is less than 1.0. The excess cancer risk for benzo(a)pyrene toxic equivalency concentration, the only contaminant type subject to the excess cancer risk calculation, is 1.83×10^{-7}, which is less than the individual excess carcinogenic risk criteria of less than 1×10^{-6} and the cumulative excess carcinogenic risk criteria of less than 1×10^{-5}.

7.0 STATEMENT OF PROTECTIVENESS

The 600-326 waste site has been evaluated in accordance with the Final Action ROD (EPA 2014) and the 100 Area RDR/RAWP (DOE-RL 2014). Verification sampling was performed and the analytical results indicate that the residual concentrations of COCs met the CULs and associated RAOs for protection of human health, groundwater protection, and surface water protection. In accordance with this evaluation, the verification sampling results support a reclassification of the 600-326 waste site to Final Closed Out.

8.0 REFERENCES

40 CFR 141, "National Primary Drinking Water Regulations," *Code of Federal Regulations*, as amended.

BHI, 2001, *Calculation of Total Uranium Activity Corresponding to a Maximum Contaminant Level for Total Uranium of 30 Micrograms per Liter in Groundwater*, 0100X-CA-V0038, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

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Ecology, 2015, Cleanup Levels and Risk Calculations (CLARC) Database, Washington State Department of Ecology, Olympia, Washington, https://fortress.wa.gov/ecy/clarc/CLARCHome.aspx.

Ecology, EPA, and DOE, 1989, *Hanford Federal Facility Agreement and Consent Order,* Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington.

ENV-1, *Environmental Monitoring & Management*, Washington Closure Hanford, Richland, Washington.

EPA, 1989, *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part A)*, Interim Final, EPA/540/1-89/002, Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, D.C.

EPA, 2014, *Record of Decision, Hanford 100 Area Superfund Site, 100-FR-1, 100-FR-2, 100-FR-3, 100-IU-2, and 100-IU-6 Operable Units,* U.S. Environmental Protection Agency, Region 10, Seattle, Washington.

WAC 173-340, "Model Toxics Control Act – Cleanup," *Washington Administrative Code,* as amended.

WCH, 2011, *Work Instruction for Verification Sampling of the Combined 100-IU-2/6 Waste Sites, 600-298, 600-299, 300-300, 600-303, 600-305, 600-306, 600-307, 600-308, 600-309, 600-310, 600-311, 600-312, 600-313, 600-314, 600-316, 600-317, 600-318, 600-319, 600-320, 600-321, 600-324, 600-325, 600-326, 600-328,* 0600X-WI-G0070, Rev. 0, Washington Closure Hanford, Richland, Washington.

APPENDIX A

CONFIRMATORY SAMPLING RESULTS

Table A-1. 600-326 Confirmatory Sample Results (6 pages).

Metals

Sample location	HEIS Number	Sample Date	Aluminum			Antimony			Arsenic			Barium			Beryllium		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
Location 1 black material	J1B769	10/28/2010	4250		1.5	0.36	U	0.36	2.2		0.62	65.6		0.072	0.031	U	0.031
Duplicate of J1B769	J1B770	10/28/2010	4110		1.3	0.33	U	0.33	2.0		0.57	66.1		0.066	0.044	B	0.028
Location 2 black material	J1B771	10/28/2010	4560		1.6	0.39	U	0.39	7.9		0.68	105		0.078	0.034	U	0.034
Equipment blank	J1B768	10/28/2010	140		1.5	0.37	U	0.37	0.64	U	0.64	1.9		0.074	0.042	B	0.032

Sample location	HEIS Number	Sample Date	Boron			Cadmium			Calcium			Chromium			Cobalt		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
Location 1 black material	J1B769	10/28/2010	0.92	U	0.92	0.068	B	0.039	1710		13.3	7.0		0.055	3.8		0.094
Duplicate of J1B769	J1B770	10/28/2010	0.84	U	0.84	0.057	B	0.035	1630		12.2	5.8		0.050	3.3		0.086
Location 2 black material	J1B771	10/28/2010	1.2	B	1.0	0.042	U	0.042	9130		14.4	22.6		0.059	0.63	B	0.10
Equipment blank	J1B768	10/28/2010	0.95	U	0.95	0.040	U	0.040	44.3	B	13.7	0.14	B	0.056	0.097	U	0.097

Sample location	HEIS Number	Sample Date	Copper			Iron			Lead			Magnesium			Manganese		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
Location 1 black material	J1B769	10/28/2010	9.1	J	0.20	17200		3.6	10.1		0.25	2600		3.5	157		0.094
Duplicate of J1B769	J1B770	10/28/2010	8.7	J	0.19	13600		3.3	10.7		0.23	2600		3.2	145		0.086
Location 2 black material	J1B771	10/28/2010	8.6	J	0.22	33800		3.9	19.1		0.28	893		3.8	51.1		0.10
Equipment blank	J1B768	10/28/2010	0.37	BJC	0.21	275		3.7	0.29	B	0.26	21.7		3.6	4.9		0.097

Sample location	HEIS Number	Sample Date	Mercury			Molybdenum			Nickel			Potassium			Selenium		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
Location 1 black material	J1B769	10/28/2010	0.0054	U	0.0054	0.25	U	0.25	6.4		0.12	1240		38.7	0.81	U	0.81
Duplicate of J1B769	J1B770	10/28/2010	0.0054	U	0.0054	0.22	U	0.22	5.6		0.11	1260		35.4	0.74	U	0.74
Location 2 black material	J1B771	10/28/2010	0.0081	BM	0.0062	0.27	U	0.27	1.7	B	0.13	4460		42.0	0.88	U	0.88
Equipment blank	J1B768	10/28/2010	0.0053	U	0.0053	0.25	U	0.25	0.12	U	0.12	67.6	B	39.8	0.83	U	0.83

Sample location	HEIS Number	Sample Date	Silicon			Silver			Sodium			Vanadium			Zinc		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
Location 1 black material	J1B769	10/28/2010	126	J	2.0	0.15	U	0.15	87.7	B	55.6	41.6		0.089	27.1		0.38
Duplicate of J1B769	J1B770	10/28/2010	174	J	1.8	0.14	U	0.14	93.5	B	50.9	24.7		0.081	23.8		0.34
Location 2 black material	J1B771	10/28/2010	190	J	2.1	0.16	U	0.16	3370		60.4	37.5		0.096	11.2		0.41
Equipment blank	J1B768	10/28/2010	68.5	J	2.0	0.16	U	0.16	57.3	U	57.3	0.34	B	0.091	1.2		0.39

Table A-1. 600-326 Confirmatory Sample Results (6 pages).

Anions											
Sample Location	HEIS Number	Sample Date	Bromide			Chloride			Fluoride		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
Location 1 black material	J1B769	10/28/2010	0.39	U	0.39	2.0	U	2.0	1.1	B	0.83
Duplicate of J1B769	J1B770	10/28/2010	0.39	U	0.39	2.0	U	2.0	1.6	B	0.84
Location 2 black material	J1B771	10/28/2010	1.5	B	0.44	2.2	U	2.2	1.5	B	0.93
Equipment blank	J1B768	10/28/2010									

Sample Location	HEIS Number	Sample Date	Nitrogen in			Nitrogen in Nitrite			Nitrogen in		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
Location 1 black material	J1B769	10/28/2010	0.59	B	0.32	0.34	U	0.34	0.53	BM	0.36
Duplicate of J1B769	J1B770	10/28/2010	0.52	B	0.32	0.34	U	0.34	0.38	B	0.36
Location 2 black material	J1B771	10/28/2010	0.36	U	0.36	0.38	U	0.38	0.41	U	0.41
Equipment blank	J1B768	10/28/2010									

Sample Location	HEIS Number	Sample Date	Phosphorous in			Sulfate			Sulfide		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
Location 1 black material	J1B769	10/28/2010	2.1	BJC	1.2	312		1.7	2.4	UN	2.4
Duplicate of J1B769	J1B770	10/28/2010	2.7	BJC	1.3	260		1.8	2.4	U	2.4
Location 2 black material	J1B771	10/28/2010	1.4	U	1.4	51600	D	196	2.7	U	2.7
Equipment blank	J1B768	10/28/2010									

Sample Location	HEIS Number	Sample Date	pH
Location 1 black material	J1B769	10/28/2010	3.73
Duplicate of J1B769	J1B770	10/28/2010	3.87
Location 2 black material	J1B771	10/28/2010	2.44
Equipment blank	J1B768	10/28/2010	

Table A-1. 600-326 Confirmatory Sample Results. (6 Pages)

Total Petroleum Hydrocarbons (TPH)								
Sample Location	HEIS Number	Sample Date	TPH - diesel range			TPH - diesel range - extended		
			ug/kg	Q	PQL	ug/kg	Q	PQL
Location 1 black material	J1B769	10/28/2010	7900	N	660	61000	N	970
Duplicate of J1B769	J1B770	10/28/2010	4200		660	42000		980
Location 2 black material	J1B771	10/28/2010	7200		770	12000		1100
Equipment blank	J1B768	10/28/2010						

Table A-1. 600-326 Confirmatory Sample Results (6 pages).												
CONSTITUENT	J1B769			J1B770			J1B771			J1B768		
	10/28/2010			10/28/2010			10/28/2010			10/28/2010		
	Location 1 black material			Duplicate of J1B769			Location 2 black material			Equipment blank		
	ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL
Semivolatile Organic Compounds (SVOCs)												
1,2,4-Trichlorobenzene	29	U	29	29	U	29	30	U	30	28	U	28
1,2-Dichlorobenzene	22	U	22	22	U	22	24	U	24	22	U	22
1,3-Dichlorobenzene	12	U	12	12	U	12	13	U	13	12	U	12
1,4-Dichlorobenzene	14	U	14	14	U	14	15	U	15	13	U	13
2,4,5-Trichlorophenol	10	U	10	10	U	10	11	U	11	9.9	U	9.9
2,4,6-Trichlorophenol	10	U	10	10	U	10	11	U	11	9.9	U	9.9
2,4-Dichlorophenol	10	U	10	10	U	10	11	U	11	9.9	U	9.9
2,4-Dimethylphenol	67	U	67	67	U	67	72	U	72	65	U	65
2,4-Dinitrophenol	340	U	340	340	U	340	360	U	360	330	U	330
2,4-Dinitrotoluene	67	U	67	67	U	67	72	U	72	65	U	65
2,6-Dinitrotoluene	29	U	29	29	U	29	30	U	30	28	U	28
2-Chloronaphthalene	10	U	10	10	U	10	11	U	11	9.9	U	9.9
2-Chlorophenol	21	U	21	21	U	21	23	U	23	21	U	21
2-Methylnaphthalene	19	U	19	19	U	19	21	U	21	19	U	19
2-Methylphenol (cresol, o-)	13	U	13	13	U	13	14	U	14	13	U	13
2-Nitroaniline	51	U	51	51	U	51	54	U	54	50	U	50
2-Nitrophenol	10	U	10	10	U	10	11	U	11	9.9	U	9.9
3+4 Methylphenol (cresol, m+p)	34	U	34	34	U	34	36	U	36	33	U	33
3,3'-Dichlorobenzidine	92	U	92	92	U	92	98	U	98	89	U	89
3-Nitroaniline	75	U	75	75	U	75	79	U	79	72	U	72
4,6-Dinitro-2-methylphenol	340	U	340	340	U	340	360	U	360	330	U	330
4-Bromophenylphenyl ether	19	U	19	19	U	19	21	U	21	19	U	19
4-Chloro-3-methylphenol	67	U	67	67	U	67	72	U	72	65	U	65
4-Chloroaniline	84	U	84	84	U	84	89	U	89	81	U	81
4-Chlorophenylphenyl ether	21	U	21	21	U	21	23	U	23	21	U	21
4-Nitroaniline	74	U	74	74	U	74	79	U	79	72	U	72
4-Nitrophenol	99	U	99	99	U	99	110	U	110	96	U	96
Acenaphthene	11	U	11	11	U	11	11	U	11	10	U	10
Acenaphthylene	17	U	17	17	U	17	18	U	18	17	U	17
Anthracene	17	U	17	17	U	17	18	U	18	17	U	17
Benzo(a)anthracene	20	U	20	20	U	20	22	U	22	20	U	20
Benzo(a)pyrene	20	U	20	20	U	20	22	U	22	20	U	20
Benzo(b)fluoranthene	27	U	27	27	U	27	29	U	29	26	U	26
Benzo(ghi)perylene	16	U	16	16	U	16	17	U	17	16	U	16
Benzo(k)fluoranthene	41	U	41	41	U	41	44	U	44	40	U	40
Bis(2-chloro-1-methylethyl)ether	23	U	23	24	U	24	25	U	25	23	U	23
Bis(2-Chloroethoxy)methane	23	U	23	24	U	24	25	U	25	23	U	23
Bis(2-chloroethyl) ether	17	U	17	17	U	17	18	U	18	16	U	16
Bis(2-ethylhexyl) phthalate	47	U	47	83	J	47	50	U	50	80	J	46
Butylbenzylphthalate	44	U	44	44	U	44	47	U	47	43	U	43
Carbazole	37	U	37	37	U	37	39	U	39	36	U	36
Chrysene	28	U	28	28	U	28	29	U	29	27	U	27
Di-n-butylphthalate	30	U	19	30	U	19	32	U	21	29	U	29
Di-n-octylphthalate	15	U	20	15	U	20	16	U	22	14	U	14
Dibenz[a,h]anthracene	19	U	27	19	U	27	21	U	28	19	U	19
Dibenzofuran	20	U	23	20	U	24	22	U	25	20	U	20
Diethyl phthalate	27	U	30	27	U	30	28	U	32	26	U	26
Dimethyl phthalate	23	U	15	24	U	15	25	U	16	23	U	23
Fluoranthene	37	U	37	37	U	37	39	U	39	36	U	36
Fluorene	18	U	18	18	U	18	20	U	20	18	U	18

Table A-1. 600-326 Confirmatory Sample Results (6 pages).

CONSTITUENT	J1B769			J1B770			J1B771			J1B768		
	10/28/2010			10/28/2010			10/28/2010			10/28/2010		
	Location 1 black material			Duplicate of J1B769			Location 2 black material			Equipment blank		
	ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL
SVOCs (continued)												
Hexachlorobenzene	30	U	30	30	U	30	32	U	32	29	U	29
Hexachlorobutadiene	10	U	10	10	U	10	11	U	11	9.9	U	9.9
Hexachlorocyclopentadiene	51	U	51	51	U	51	54	U	54	50	U	50
Hexachloroethane	22	U	22	22	U	22	23	U	23	21	U	21
Indeno(1,2,3-cd)pyrene	22	U	22	22	U	22	24	U	24	22	U	22
Isophorone	17	U	17	17	U	17	18	U	18	17	U	17
N-Nitroso-di-n-dipropylamine	32	U	32	32	U	32	34	U	34	31	U	31
N-Nitrosodiphenylamine	21	U	22	21	U	22	23	U	24	21	U	21
Naphthalene	32	U	32	32	U	32	34	U	34	31	U	31
Nitrobenzene	22	U	21	22	U	21	24	U	23	22	U	22
Pentachlorophenol	340	U	340	340	U	340	360	U	360	330	U	330
Phenanthrene	17	U	17	17	U	17	18	U	18	17	U	17
Phenol	18	U	18	18	U	18	20	U	20	18	U	18
Pyrene	12	U	12	14	J	12	13	U	13	12	U	12
Polychlorinated Biphenyls (PCBs)												
Aroclor-1016	28	UD	28	28	UD	28	31	UD	31			
Aroclor-1221	81	UD	81	81	UD	81	90	UD	90			
Aroclor-1232	20	UD	20	20	UD	20	23	UD	23			
Aroclor-1242	47	UD	47	47	UD	47	53	UD	53			
Aroclor-1248	47	UD	47	47	UD	47	53	UD	53			
Aroclor-1254	26	UD	26	26	UD	26	29	UD	29			
Aroclor-1260	26	UD	26	26	UD	26	29	UD	29			
Polycyclic Aromatic Hydrocarbons (PAHs)												
Acenaphthene	10	U	10	9.7	U	9.7	220	X	11			
Acenaphthylene	9.3	U	9.3	8.8	U	8.8	26	JX	10			
Anthracene	3.1	U	3.1	3.0	U	3.0	3.4	U	3.4			
Benzo(a)anthracene	3.3	U	3.3	3.1	U	3.1	950	N	3.5			
Benzo(a)pyrene	39	X	6.6	9.2	JX	6.2	1800	N	7.1			
Benzo(b)fluoranthene	18	X	4.3	4.1	U	4.1	1100	NX	4.7			
Benzo(ghi)perylene	29	J	7.4	7.0	U	7.0	380	NX	8.0			
Benzo(k)fluoranthene	13	JX	4.1	6.3	JX	3.8	650	NX	4.4			
Chrysene	13	JX	5	4.7	U	4.7	1400	N	5.4			
Dibenz[a,h]anthracene	11	U	11	11	U	11	510		12			
Fluoranthene	13	U	13	13	U	13	2100	NX	14			
Fluorene	5.4	U	5.4	5.1	U	5.1	5.9	U	5.9			
Indeno(1,2,3-cd)pyrene	12	U	12	12	U	12	730	NX	13			
Naphthalene	12	U	12	12	U	12	51	JX	13			
Phenanthrene	47	X	12	12	U	12	170		13			
Pyrene	12	U	12	12	U	12	1800	N	13			

Table A-1. 600-326 Confirmatory Sample Results (6 pages).												
CONSTITUENT	J1B769			J1B770			J1B771			J1B768		
	10/28/2010			10/28/2010			10/28/2010			10/28/2010		
	Location 1 black material			Duplicate of J1B769			Location 2 black material			Equipment blank		
	ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL
Pesticides												
Aldrin	0.25	U	0.25	0.24	U	0.24	0.29	U	0.29			
Alpha-BHC	0.22	U	0.22	0.20	U	0.20	0.25	U	0.25			
alpha-Chlordane	0.33	U	0.33	0.31	UN	0.31	0.37	U	0.37			
beta-1,2,3,4,5,6-Hexachlorocyclohexane	0.67	U	0.67	0.63	UN	0.63	0.76	U	0.76			
Delta-BHC	0.41	U	0.41	0.38	UN	0.38	0.46	U	0.46			
Dichlorodiphenyldichloroethane	0.55	U	0.55	0.52	U	0.52	0.94	J	0.63			
Dichlorodiphenyldichloroethylene	1.4	JX	0.24	1.0	JX	0.23	2.7	X	0.27			
Dichlorodiphenyltrichloroethane	1.8		0.60	1.2	J	0.56	5.9		0.68			
Dieldrin	0.21	U	0.21	0.20	U	0.20	0.24	U	0.24			
Endosulfan I	0.18	U	0.18	0.17	U	0.17	0.20	U	0.20			
Endosulfan II	0.29	U	0.29	0.27	UN	0.27	0.33	U	0.33			
Endosulfan sulfate	0.28	U	0.28	0.26	UN	0.26	0.32	U	0.32			
Endrin	0.31	U	0.31	0.29	UN	0.29	0.35	U	0.35			
Endrin aldehyde	0.17	U	0.17	0.16	UN	0.16	0.20	U	0.20			
Endrin ketone	0.50	U	0.50	0.47	UN	0.47	0.56	U	0.56			
Gamma-BHC (Lindane)	0.47	U	0.47	0.44	U	0.44	0.53	U	0.53			
gamma-Chlordane	0.27	U	0.27	0.25	U	0.25	0.30	U	0.30			
Heptachlor	0.22	U	0.22	0.20	U	0.20	0.25	U	0.25			
Heptachlor epoxide	0.43	U	0.43	0.41	U	0.41	0.49	U	0.49			
Methoxychlor	0.46	U	0.46	0.43	U	0.43	0.52	U	0.52			
Toxaphene	16	U	16	15	U	15	18	U	18			

APPENDIX B

CALCULATIONS

APPENDIX B

CALCULATIONS

The calculations in this appendix are kept in the active Washington Closure Hanford project files and are available upon request. When the project is completed, the files will be stored in a U.S. Department of Energy, Richland Operations Office repository. These calculations have been prepared in accordance with ENG-1, *Engineering Services*, ENG-1-4.5, "Project Calculations," Washington Closure Hanford, Richland, Washington. The following calculations are provided in this appendix:

DISCLAIMER FOR CALCULATIONS

The calculations provided in this appendix have been generated to document compliance with established cleanup levels. These calculations should be used in conjunction with other relevant documents.

Acrobat 8.0

CALCULATION COVER SHEET

Project Title: 600 Area Closure Operations **Job No. 14655**

Area: 600

Discipline: Environmental *Calculation No: 0600X-CA-V0199

Subject: 600-326 Waste Site Relative Percent Difference (RPD) and Direct Contact Hazard Quotient and Carcinogenic Risk Calculations

Computer Program: Excel Program No: Excel 2010

The attached calculations have been generated to document compliance with established cleanup levels. These calculations should be used in conjunction with other relevant documents in the administrative record.

Committed Calculation ☒ Preliminary ☐ Superseded ☐ Voided ☐

Rev.	Sheet Numbers	Originator	Checker	Reviewer	Approval	Date
0	Cover = 1 Summary = 7 Attachment 1 = 3 Total = 11	I. B. Berezovskiy	R. J. Nielson	T. Q. Howell	S. G. Wilkinson	12/28/15

SUMMARY OF REVISION

WCH-DE-018 (05/08/2007) *Obtain Calc. No. from Document Control and Form from Intranet

Washington Closure Hanford CALCULATION SHEET

Originator:	I. B. Berezovskiy	Date:	11/5/2015	Calc. No.:	0600X-CA-V0199	Rev.:	0
Project:	600 Area Closure Operations	Job No:	14655	Checked:	R. J. Nielson	Date:	11/5/2015
Subject:	600-326 Waste Site RPD and Direct Contact Hazard Quotient and Carcinogenic Risk Calculations					Sheet No.	1 of 7

PURPOSE:

Using sample data from Attachment 1 provide documentation to support the calculation of the direct contact hazard quotient (HQ) and excess carcinogenic risk for the 600-326 waste site. In accordance with the cleanup levels (CULs) in the *Record of Decision for the 100-FR-1, 100-FR-2, 100-FR-3, 100-IU-2, and 100-IU-6 Operable Units* (EPA 2014) and the criteria outlined in the remedial design report/remedial action work plan (RDR/RAWP) (DOE-RL 2014) the following must be met:

1) An HQ of <1.0 for all individual noncarcinogens
2) A cumulative HQ of <1.0 for noncarcinogens
3) An excess cancer risk of $<1 \times 10^{-6}$ for individual carcinogens
4) A cumulative excess cancer risk of $<1 \times 10^{-5}$ for carcinogens.

Also, calculate the relative percent difference (RPD) for primary-duplicate sample pairs from 600-326 waste site verification sampling, as necessary.

GIVEN/REFERENCES:

1) DOE-RL, 2013, *100 Area Remedial Action Sampling and Analysis Plan,* DOE/RL-96-22, Rev. 5, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

2) DOE-RL, 2014a, *Remedial Design Report/Remedial Action Work Plan Addendum for 100-FR-1, 100-FR-2, 100-IU-2 and 100-IU-6 Soils,* DOE/RL-2014-44-ADD1, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

3) DOE-RL, 2014b, *Remedial Investigation/Feasibility Study for the 100-FR-1, 100-FR-2, 100-FR-3, 100-IU-2, and 100-IU-6 Operable Units*, DOE/RL-2010-98, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

4) Ecology, 2007, WAC 173-340-708 (8), "Model Toxic Control Act - Cleanup" Washington Administrative Code, November 2007 Revision.

5) EPA, 1994, *USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review*, EPA 540/R-94/013, U.S. Environmental Protection Agency, Washington, D.C.

6) EPA, 2014, *Record of Decision, Hanford 100 Area Superfund Site, 100-FR-1, 100-FR-2, 100-FR-3, 100-IU-2, and 100-IU-6 Operable Units,* September 2014, U. S. Environmental Protection Agency, Region 10, Seattle, Washington.

7) WCH, 2015, *Cleanup Verification Package for the 600-326, Odorous Black Material Waste Site,* Attachment to Waste Site Reclassification Form 2015-054, Washington Closure Hanford, Richland, Washington.

Washington Closure Hanford CALCULATION SHEET

Originator:	I. B. Berezovskiy	Date:	11/5/2015	Calc. No.:	0600X-CA-V0199	Rev.:	0
Project:	600 Area Closure Operations	Job No:	14655	Checked:	R. J. Nielson	Date:	11/5/2015
Subject:	600-326 Waste Site RPD and Direct Contact Hazard Quotient and Carcinogenic Risk Calculations					Sheet No.	2 of 7

SOLUTION:

Within this calculation, per Ecology, 2007, compliance with cleanup levels for mixtures of carcinogenic polycyclic aromatic hydrocarbons (PAHs) is determined by considering mixtures of carcinogenic PAHs as a single hazardous substance and using the cleanup levels established for benzo(a)pyrene (BaP) as the cleanup level for mixtures of carcinogenic PAHs. Statistical values representing the PAH concentrations for each decision unit are determined, or the maximum detected value is selected for focused samples. The selected value for each PAH is multiplied by the corresponding toxicity equivalency concentration (TEC) as shown in Table 1 to obtain the BaP TEC for that carcinogenic PAH. The TECs of all the carcinogenic PAHs are summed to obtain the total BaP TEC for the subject decision unit. This value will be used in the Direct Contact Hazard Quotient and Carcinogenic Risk Calculation.

1) Generate an HQ for each noncarcinogenic constituent detected above background or required detection limit/practical quantitation limit and compare it to the individual HQ of <1.0 (DOE-RL 2014a).

2) Sum the HQs and compare this value to the cumulative HQ of <1.0.

3) Generate an excess cancer risk value for each carcinogenic constituent detected above background or required detection limit/practical quantitation limit and compare it to the excess cancer risk of $<1 \times 10^{-6}$ (DOE-RL 2014a).

4) Sum the excess cancer risk value(s) and compare it to the cumulative cancer risk of $<1 \times 10^{-5}$.

5) Use data from Attachment 1 to perform the RPD calculations for primary-duplicate sample pairs, as required.

METHODOLOGY:

The 600-326 waste site consists of two subsites: 600-326:1 and 600-326:2. The 600-326 waste site underwent focused (composite) verification sampling at two locations. One focused (composite) sample was collected from each of the subsites (600-326:1 and 600-326:2). One duplicate and one split sample were also collected. The direct contact hazard quotient and carcinogenic risk calculations for the 600-326 waste site were conservatively calculated for the entire waste site using the greatest of the maximum soil sample results from Attachment 1. Of the contaminants of concern (COC) for this site, BaP TEC required HQ and risk calculations because polycyclic aromatic hydrocarbons were detected and a Washington State or Hanford Site background value is not available. Lead was detected above background; however, lead does not have a reference dose for calculation of a hazard quotient because toxic effects of lead are correlated with blood-lead levels rather than exposure levels or daily intake.

As a further evaluation, HQ and excess cancer risk calculations were prepared for non-COC analytes that were detected and Washington State or Hanford Site background value are not available. Fluoranthene and phenanthrene, the two non-COC constituents detected, are included in the HQ and excess cancer risk calculations. The calculations for COCs are summed with non-COCs for information only (Table 2).

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Calculations for the 600-326 waste site were performed using parameters and equations from the RDR/RAWP (DOE-RL 2014a). An example of the HQ and risk calculations of COCs for the 600-326 waste site is presented below:

1) To calculate the HQ, the maximum value for each constituent that qualifies for the hazard quotient calculation is multiplied by the daily intake factor (1.25×10^{-5}) as explained in Appendix C of the RDR/RAWP (DOE-RL 2014a) and divided by the reference dose (RfD) for a specific constituent as shown in Table C3 of the RDR/RAWP (DOE-RL 2014a). There were no COC constituents that qualified for the hazard quotient calculation; therefore, hazard quotient values are zero. Comparing this value, and all other individual values for the 600-326 waste site calculation, to the requirement of <1.0, this criterion is met.

2) After the HQ calculation is completed for the appropriate COCs, the cumulative HQ is obtained by summing the individual values. To avoid errors due to intermediate rounding, the individual HQ values prior to rounding are used for this calculation. The sum of the HQ values is zero for 600-326 waste site; therefore, the requirement of <1.0 is met.

3) To calculate the excess cancer risk, the maximum value for BaP TEC, 0.025 mg/kg is multiplied by the daily intake factor (1.00×10^{-6}), as explained in Appendix C of the RDR/RAWP (DOE-RL 2014a), and the cancer potency factor of 7.30 mg/kg-day, with a resulting value of 1.83×10^{-7}. Comparing this value to the threshold of $<1 \times 10^{-6}$, this criterion is met.

4) After these calculations are completed for the carcinogenic analytes, the cumulative excess cancer risk is obtained by summing the individual values. The sum of the cumulative cancer risk values is 1.83×10^{-7} for the 600-326 waste site calculation. Comparing this value to the requirement of $<1 \times 10^{-5}$, this criterion is met.

5) The RPD is calculated when both the primary value and the duplicate value for a given analyte are above detection limits and are greater than 5 times the target detection limit (TDL). The TDL is a laboratory detection limit pre-determined for each analytical method and is listed for certain analytes in Table II-1 of the SAP (DOE-RL 2013). Other analytes will have their own pre-determined constituents and will have their own TDLs based on the laboratory and method used. Where direct evaluation of the attached sample data showed that a given analyte was not detected in the primary and/or duplicate sample, further evaluation of the RPD value was not performed. The RPD calculations use the following formula:

$$RPD = [\ |M-D|/((M+D)/2)]*100$$

where, M = main sample value D = duplicate sample value

When an analyte is detected in the primary or duplicate sample, but was quantified at less than 5 times the TDL in one or both samples, an additional parameter is evaluated. In this case, if the difference between the primary and duplicate results exceeds a control limit of 2 times the TDL, further assessment regarding the usability of the data is performed. This assessment is provided in the data quality assessment section of the CVP.

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For quality assurance/quality control (QA/QC) duplicate RPD calculations, a value less than 30% indicates the data compare favorably. For regulatory splits, a threshold of 35% is used (EPA 1994). If the RPD is greater than 30% (or 35% for regulatory split data), further investigation regarding the usability of the data is performed. No split samples were collected for the verification sampling of the subject site. Additional discussion is provided in the data quality assessment section of the applicable CVP (WCH 2015), as necessary.

RESULTS:

Table 1 shows the results for the BaP TEC calculation for 600-326 waste site. The maximum BaP TEC calculation will be included in the direct contact hazard quotient.

1) List individual noncarcinogens and corresponding HQs >1.0: None
2) List the cumulative noncarcinogenic HQ >1.0: None
3) List individual carcinogens and corresponding excess cancer risk >1 x 10^{-6}: None
4) List the cumulative excess cancer risk for carcinogens >1 x 10^{-5}: None

Table 2 shows the results of the hazard quotient and excess cancer risk calculations for the 600-326 waste site.

5) The evaluation of the QA/QC duplicate RPD calculations are performed within the data quality assessment section of the CVP.

Table 3 shows the results of the RPD calculations for the 600-326 waste site.

Table 1. 600-326 Waste Site Benzo(a)Pyrene Toxic Equivalent Concentration Calculations.

Carcinogenic Polycyclicaromatic Hydrocarbons	Maximum Result (mg/kg) [a]	Toxic Equivalency Factor (Unitless)	BAP TEC (mg/kg)
Benzo[a]pyrene	0.021	1	0.021
Benzo[a]anthracene	0.0040	0.1	0.00040
Benzo[b]fluoranthene	0.020	0.1	0.0020
Benzo[k]fluoranthene	--	0.1	0
Chrysene	--	0.01	0
Dibenz[a,h]anthracene	--	0.1	0
Indeno[1,2,3-cd]pyrene	0.016	0.1	0.0016
		Total BAP TEC:	0.025

[a] From Attachment 1.
-- = not detected
BAP TEC = Benzo(a)pyrene toxic equivalent concentration

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Table 2. Direct Contact HQ and Excess Cancer Risk Results for the 600-326 Waste Site.

COCs	Maximum Value[a] (mg/kg)	Oral Reference Dose (RfD)[b] (mg/kg-day)	Hazard Quotient	Oral Carcinogenic Potency Factor[b] (mg/kg-day)$^{-1}$	Excess Carcinogenic Risk
Lead[c]	12.0	--	--	--	--
BAP equivalence concentration[d]	0.025	--	--	7.30E+00	1.83E-07
COCs Cumulative Hazard Quotient:			**0.00E+00**		
COCs Cumulative Excess Carcinogenic Risk:					**1.83E-07**

Non-COCs	Maximum Value[a] (mg/kg)	Oral Reference Dose (RfD)[b] (mg/kg-day)	Hazard Quotient	Oral Carcinogenic Potency Factor[b] (mg/kg-day)$^{-1}$	Excess Carcinogenic Risk
Semivolatile Organic Compounds, Including Polycyclic Aromatic Hydrocarbons					
Benzo(a)anthracene[e]	0.0040	--	--	7.30E-01	--
Benzo(b)fluoranthene[e]	0.020	--	--	7.30E-01	--
Fluoranthene	0.036	4.00E-02	1.13E-05	--	--
Indeno(1,2,3-cd)pyrene[e]	0.016	--	--	7.30E-01	--
Phenanthrene[f]	0.017	3.00E-01	7.08E-07	--	--
Pesticides and Polychlorinated Biphenyls					
DDE, 4,4'-	0.059	--	--	3.40E-01	2.01E-08
Non-COCs Cumulative Hazard Quotient:			**1.20E-05**		
Non-COCs Cumulative Excess Carcinogenic Risk:					**2.01E-08**

Total Cumulative Hazard Quotient:	**1.20E-05**	
Total Cumulative Excess Cancer Risk:		**2.03E-07**

a = From Attachment 1. Analytes quantified below background values listed in Table G-13 of the 100-F/IU RI/FS (DOE-RL 2014b) are not included in risk calculations.
b = Values obtained from Table C-3 of the RDR/RAWP (DOE-RL 2014a).
c = Lead does not have a reference dose or cancer potency factor because toxic effects of lead are correlated with blood-lead levels rather than exposure levels or daily intake.
d = From Table 1. Evaluation of the compliance of BAP with cleanup levels includes the toxic equivalency concentrations of detected carcinogenic PAHs.
e = Included in BAP equivalence concentration.
f = Toxicity data for these chemicals are not available. Cleanup levels are based on surrogate chemicals: Contaminant: phenathrene; surrogate: anthracene.
-- = no value / not applicable
BAP = benzo(a)pyrene
COC = contaminant of concern

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Table 3. Relative Percent Difference Calculations for the 600-326 Waste Site (2 pages).

Duplicate Analysis - 600-326 Waste Site

Sampling Area	Sample Number	Sample Date	Aluminum			Arsenic			Barium			Beryllium		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
Area 1	J1V846	10/1/2015	7590		1.5	3.5		0.65	80.8		0.075	0.28		0.033
Duplicate of J1V846	J1V848	10/1/2015	7620		1.6	3.4		0.68	81.8		0.079	0.28		0.034

Analysis:

TDL		5	10	2	0.2
Duplicate Analysis	Both > PQL?	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)
	Both >5xTDL?	Yes (calc RPD)	No-Stop (acceptable)	Yes (calc RPD)	No-Stop (acceptable)
	RPD	0.4%		1.2%	
	Difference > 2 TDL?	Not applicable	No - acceptable	Not applicable	No - acceptable

Duplicate Analysis - 600-326 Waste Site

Sampling Area	Sample Number	Sample Date	Boron			Cadmium			Calcium			Chromium		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
Area 1	J1V846	10/1/2015	1.2	B	0.97	0.14	B	0.041	3570		13.9	9.4		0.057
Duplicate of J1V846	J1V848	10/1/2015	1.3	B	1.0	0.10	B	0.042	3570		14.6	8.9		0.060

Analysis:

TDL		2	0.2	100	1
Duplicate Analysis	Both > PQL?	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)
	Both >5xTDL?	No-Stop (acceptable)	No-Stop (acceptable)	Yes (calc RPD)	Yes (calc RPD)
	RPD			0.0%	5.5%
	Difference > 2 TDL?	No - acceptable	No - acceptable	Not applicable	Not applicable

Duplicate Analysis - 600-326 Waste Site

Sampling Area	Sample Number	Sample Date	Cobalt			Copper			Iron			Lead		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
Area 1	J1V846	10/1/2015	8.1		0.10	11.3		0.21	20700	X	3.8	6.0		0.27
Duplicate of J1V846	J1V848	10/1/2015	9.2		0.10	10.8		0.22	20200	X	3.9	5.3		0.28

Analysis:

TDL		2	1	5	5
Duplicate Analysis	Both > PQL?	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)
	Both >5xTDL?	No-Stop (acceptable)	Yes (calc RPD)	Yes (calc RPD)	No-Stop (acceptable)
	RPD		4.5%	2.4%	
	Difference > 2 TDL?	No - acceptable	Not applicable	Not applicable	No - acceptable

Duplicate Analysis - 600-326 Waste Site

Sampling Area	Sample Number	Sample Date	Magnesium			Manganese			Nickel			Potassium		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
Area 1	J1V846	10/1/2015	4260		3.7	307		0.099	9.8		0.12	1700		40.6
Duplicate of J1V846	J1V848	10/1/2015	4160		3.8	154		0.10	9.5		0.13	1720		42.5

Analysis:

TDL		75	5	4	400
Duplicate Analysis	Both > PQL?	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)
	Both >5xTDL?	Yes (calc RPD)	Yes (calc RPD)	No-Stop (acceptable)	No-Stop (acceptable)
	RPD	2.4%	*66.4%*		
	Difference > 2 TDL?	Not applicable	Not applicable	No - acceptable	No - acceptable

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Table 3. Relative Percent Difference Calculations for the 600-326 Waste Site (2 pages).

Duplicate Analysis - 600-326 Waste Site

Sampling Area	Sample Number	Sample Date	Silicon			Sodium			Vanadium			Zinc		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
Area 1	J1V846	10/1/2015	325	NJ	5.6	192		58.4	51.9		0.093	41.8	X	0.39
Duplicate of J1V846	J1V848	10/1/2015	338	J	5.9	194		61.1	49.7		0.097	42.1	X	0.41

Analysis:

TDL		2	50	2.5	1
Duplicate Analysis	Both > PQL?	Yes (continue)	Yes (continue)	Yes (continue)	Yes (continue)
	Both >5xTDL?	Yes (calc RPD)	No-Stop (acceptable)	Yes (calc RPD)	Yes (calc RPD)
	RPD	3.9%		4.3%	0.7%
	Difference > 2 TDL?	Not applicable	No - acceptable	Not applicable	Not applicable

Duplicate Analysis - 600-326 Waste Site

Sampling Area	Sample Number	Sample Date	Sulfate		
			ug/kg	Q	PQL
Area 1	J1V846	10/1/2015	43.4		1.8
Duplicate of J1V846	J1V848	10/1/2015	43.4		1.8

Analysis:

TDL		5000
Duplicate Analysis	Both > PQL?	Yes (continue)
	Both >5xTDL?	No-Stop (acceptable)
	RPD	
	Difference > 2 TDL?	No - acceptable

CONCLUSION:

The calculations in Tables 2-3 demonstrate that the 600-326 waste site meets the requirements for the hazard quotients and carcinogenic (excess cancer) risk and RPDs, respectively, as identified in the RDR/RAWP (DOE-RL 2014a) and SAP (DOE-RL 2013). The hazard quotients and carcinogenic (excess cancer) risk and RPD calculations are for use in the CVP for this site.

Attachment 1. 600-326 Waste Site Verification Sampling Results (Metals).

Sample Location	HEIS Number	Sample Date	Aluminum			Antimony			Arsenic			Barium		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
Area 1	J1V846	10/1/2015	7590		1.5	0.38	UJ	0.38	3.5		0.65	80.8		0.075
Duplicate of J1V846	J1V848	10/1/2015	7620		1.6	0.39	UJ	0.39	3.4		0.68	81.8		0.079
Area 2	J1V847	10/1/2015	10600		1.6	0.39	UJ	0.39	6.0		0.68	113		0.078
Equipment Blank	J1V849	10/1/2015	112		1.4	0.34	UJ	0.34	0.58	U	0.58	1.3		0.067

Sample Location	HEIS Number	Sample Date	Beryllium			Boron			Cadmium			Calcium		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
Area 1	J1V846	10/1/2015	0.28		0.033	1.2	B	0.97	0.14	B	0.041	3570		13.9
Duplicate of J1V846	J1V848	10/1/2015	0.28		0.034	1.3	B	1.0	0.10	B	0.042	3570		14.6
Area 2	J1V847	10/1/2015	0.32		0.034	1.3	B	1.0	0.35		0.042	5750		14.5
Equipment Blank	J1V849	10/1/2015	0.029	U	0.029	0.87	U	0.87	0.036	U	0.036	38.3	BCUJ	12.5

Sample Location	HEIS Number	Sample Date	Chromium			Cobalt			Copper			Iron		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
Area 1	J1V846	10/1/2015	9.4		0.057	8.1		0.099	11.3		0.21	20700	X	3.8
Duplicate of J1V846	J1V848	10/1/2015	8.9		0.06	9.2		0.10	10.8		0.22	20200	X	3.9
Area 2	J1V847	10/1/2015	19.1		0.06	7.8		0.10	20.2		0.22	21600	X	3.9
Equipment Blank	J1V849	10/1/2015	0.16	BCUJ	0.051	0.089	U	0.089	0.26	B	0.19	171	X	3.4

Sample Location	HEIS Number	Sample Date	Lead			Magnesium			Manganese			Molybdenum		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
Area 1	J1V846	10/1/2015	6.0		0.27	4260		3.7	307		0.099	0.26	U	0.26
Duplicate of J1V846	J1V848	10/1/2015	5.3		0.28	4160		3.8	154		0.10	0.27	U	0.27
Area 2	J1V847	10/1/2015	12		0.28	5260		3.8	321		0.10	0.27	U	0.27
Equipment Blank	J1V849	10/1/2015	0.27	B	0.24	18.9	CUJ	3.3	3.0		0.089	0.23	U	0.23

Sample Location	HEIS Number	Sample Date	Nickel			Potassium			Selenium			Silicon		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
Area 1	J1V846	10/1/2015	9.8		0.12	1700		40.6	0.85	U	0.85	325	NJ	5.6
Duplicate of J1V846	J1V848	10/1/2015	9.5		0.13	1720		42.5	0.89	U	0.89	338	J	5.9
Area 2	J1V847	10/1/2015	15.5		0.13	1770		42.1	0.88	U	0.88	328	J	5.8
Equipment Blank	J1V849	10/1/2015	0.17	BCUJ	0.11	36.3	U	36.3	0.76	U	0.76	91.5	J	5.0

Sample Location	HEIS Number	Sample Date	Silver			Sodium			Vanadium			Zinc		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
Area 1	J1V846	10/1/2015	0.16	U	0.16	192		58.4	51.9		0.093	41.8	X	0.39
Duplicate of J1V846	J1V848	10/1/2015	0.17	U	0.17	194		61.1	49.7		0.097	42.1	X	0.41
Area 2	J1V847	10/1/2015	0.16	U	0.16	410		60.6	46.9		0.096	74.6	X	0.41
Equipment Blank	J1V849	10/1/2015	0.14	U	0.14	52.3	U	52.3	0.25	B	0.083	1.3	CXUJ	0.35

Note: Gray cells indicate not applicable.

Acronyms and notes apply to all of the tables in this attachment.

B = estimated result; result is less than the RL but greater than the MDL.

C = the analyte was detected in both the sample and the associated QC

D = sample results are obtained from a dilution.

blank, and the sample concentration was ≤5x the blank concentration.

HEIS = Hanford Environmental Information System

J = estimate

N = recovery is outside control limits.

PAH = polycyclic aromatic hydrocarbons

PEST = pestisides

PQL = practical quantitation limit

Q = qualifier

R = rejected

U = undetected

X (metals) = serial dilution in the analytical batch indicates that physical and chemical interferences are present.

X (organics) = more than 40% difference between the primary and confirmation detector results. The lower of the two results is reported.

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Attachment 1. 600-326 Waste Site Verification Sampling Results (IC Anions).

Sample Location	HEIS Number	Sample Date	Bromide			Chloride			Fluoride			Nitrogen in Nitrate		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL
Area 1	J1V846	10/1/2015	0.42	U	0.42	2.2	U	2.2	0.89	UN	0.89	0.71	BJ	0.34
Duplicate of J1V846	J1V848	10/1/2015	0.42	U	0.42	2.1	U	2.1	0.88	U	0.88	0.63	BJ	0.34
Area 2	J1V847	10/1/2015	0.44	U	0.44	2.9	B	2.2	0.92	U	0.92	2.8	J	0.35

Sample Location	HEIS Number	Sample Date	Nitrogen in Nitrite			Phosphorous in phosphate			Sulfate			%moisture (wet sample)		
			mg/kg	Q	PQL	mg/kg	Q	PQL	mg/kg	Q	PQL	%	Q	PQL
Area 1	J1V846	10/1/2015	0.36	UR	0.36	1.3	UR	1.3	43.4		1.8	9.7		0.10
Duplicate of J1V846	J1V848	10/1/2015	0.36	UR	0.36	1.3	UR	1.3	43.4		1.8	8.5		0.10
Area 2	J1V847	10/1/2015	0.38	UR	0.38	1.4	UR	1.4	3470	D	9.5	11.5		0.10

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Attachment 1. 600-326 Waste Site Verification Sampling Results (Organics).

CONSTITUENT	CLASS	J1V846, Area 1			J1V848, Duplicate of J1V846			J1V847, Area 2		
		10/01/15			10/01/15			10/01/15		
		ug/kg	Q	PQL	ug/kg	Q	PQL	ug/kg	Q	PQL
Acenaphthene	PAH	11	U	11	30	J	10	10	U	10
Acenaphthylene	PAH	9.9	U	9.9	9.3	U	9.3	9.4	U	9.4
Anthracene	PAH	3.3	U	3.3	3.1	U	3.1	3.2	U	3.2
Benzo(a)anthracene	PAH	3.5	U	3.5	3.3	U	3.3	4.0	JX	3.3
Benzo(a)pyrene	PAH	7.0	U	7.0	6.6	U	6.6	21		6.7
Benzo(b)fluoranthene	PAH	4.6	U	4.6	4.3	U	4.3	20		4.4
Benzo(ghi)perylene	PAH	7.9	U	7.9	7.4	U	7.4	7.6	U	7.6
Benzo(k)fluoranthene	PAH	4.3	U	4.3	4.1	U	4.1	4.1	U	4.1
Chrysene	PAH	5.3	U	5.3	5.0	U	5.0	5.1	UN	5.1
Dibenz[a,h]anthracene	PAH	12	U	12	11	U	11	12	U	12
Fluoranthene	PAH	14	U	14	13	U	13	36	J	14
Fluorene	PAH	5.8	U	5.8	5.4	U	5.4	5.5	U	5.5
Indeno(1,2,3-cd)pyrene	PAH	13	U	13	12	U	12	16	J	13
Naphthalene	PAH	13	U	13	12	U	12	13	U	13
Phenanthrene	PAH	13	U	13	12	U	12	17	JX	13
Pyrene	PAH	13	U	13	12	U	12	13	U	13
Aldrin	PEST	0.26	U	0.26	0.27	U	0.27	0.27	U	0.27
Alpha-BHC	PEST	0.22	U	0.22	0.23	U	0.23	0.23	U	0.23
alpha-Chlordane	PEST	0.34	UN	0.34	0.35	U	0.35	0.35	U	0.35
beta-1,2,3,4,5,6-Hexachlorocyclohexane	PEST	0.70	UN	0.70	0.73	U	0.73	0.71	U	0.71
Delta-BHC	PEST	0.42	UN	0.42	0.44	U	0.44	0.43	U	0.43
Dichlorodiphenyldichloroethane	PEST	0.57	UN	0.57	0.60	U	0.60	0.59	U	0.59
Dichlorodiphenyldichloroethylene	PEST	0.25	UN	0.25	0.26	U	0.26	0.59	JY	0.26
Dichlorodiphenyltrichloroethane	PEST	0.62	UN	0.62	0.64	U	0.64	0.63	U	0.63
Dieldrin	PEST	0.22	UN	0.22	0.23	U	0.23	0.23	U	0.23
Endosulfan I	PEST	0.18	UN	0.18	0.19	U	0.19	0.19	U	0.19
Endosulfan II	PEST	0.30	UN	0.30	0.31	U	0.31	0.31	U	0.31
Endosulfan sulfate	PEST	0.29	UN	0.29	0.30	U	0.30	0.30	U	0.30
Endrin	PEST	0.32	U	0.32	0.33	U	0.33	0.33	U	0.33
Endrin aldehyde	PEST	0.18	UJ	0.18	0.19	UJ	0.19	0.18	UJ	0.18
Endrin ketone	PEST	0.51	UN	0.51	0.53	U	0.53	0.52	U	0.52
Gamma-BHC (Lindane)	PEST	0.49	U	0.49	0.51	U	0.51	0.50	U	0.50
gamma-Chlordane	PEST	0.28	UN	0.28	0.29	U	0.29	0.29	U	0.29
Heptachlor	PEST	0.22	U	0.22	0.23	U	0.23	0.23	U	0.23
Heptachlor epoxide	PEST	0.45	U	0.45	0.47	U	0.47	0.46	U	0.46
Methoxychlor	PEST	0.47	UN	0.47	0.49	U	0.49	0.48	U	0.48
Toxaphene	PEST	17	UJ	17	17	UJ	17	17	UJ	17

Attachment	1	Sheet No.	3 of 3
Originator	I.B. Berezovksiy	Date	11/5/15
Checked	R.J. Nielson	Job No.	48655
Calc. No.	0600X-CA-V0199	Rev. No.	0

APPENDIX C

DATA QUALITY ASSESSMENT

APPENDIX C

DATA QUALITY ASSESSMENT

VERIFICATION SAMPLING

A data quality assessment (DQA) was performed to compare the verification sampling approach and resulting analytical data with the sampling and data requirements specified in the site-specific sample design (WCH 2011). This DQA was performed in accordance with site-specific data quality objectives found in the *100 Area Remedial Action Sampling and Analysis Plan* (100 Area SAP) (DOE-RL 2009).

A review of the sample design (WCH 2011), the field logbook (WCH 2015), and applicable analytical data packages has been performed as part of this DQA. All samples were collected and analyzed per the sample design.

To ensure quality data, the 100 Area SAP (DOE-RL 2009) data assurance requirements and the data validation procedure for chemical analysis (BHI 2000) is used as appropriate. This review involves evaluation of the data to determine if they are of the right type, quality, and quantity to support the intended use (i.e., closeout decisions). The DQA completes the data life cycle (i.e., planning, implementation, and assessment) that was initiated by the data quality objectives process (EPA 2006).

The 600-326 waste site consists of the 600-326:1 and 600-326:2 subsites. Verification sample data collected at the 600-326 waste site was provided by the laboratory in sample delivery group (SDG) JP1000. SDG JP1000 was submitted for third-party validation. Major and minor deficiencies are discussed for the 600-326 data set, as follows below. If no comments are made about a specific analysis, it should be assumed that no deficiencies affecting the quality of the data were found.

MAJOR DEFICIENCIES

Due to holding time exceedances in the method 9056M ion chromatography (IC) anions analysis of greater than twice the limit of 48 hours, third-party validation qualified all undetected nitrite and orthophosphate results in SDG JP1000 as rejected with "R" flags. All detected nitrite and orthophosphate data was qualified as estimated with "J" flags by third-party validation. Although nitrite and orthophosphate data is included in the cumulative IC anions analysis, these constituents are noncontaminants of concern for the 600-326 waste site. Therefore, the estimated and rejected data for nitrate and nitrite do not hinder the evaluation of the 600-326 waste site. Furthermore, phosphate is not a regulated chemical under *Washington Administrative Code* (WAC) 173-340, "Model Toxics Control Act-Cleanup."

MINOR DEFICIENCIES

SDG JP1000

This SDG comprises two focused (composite) soil samples (J1V846 and J1V847) collected from the 600-326 waste site excavation area. This SDG includes a field duplicate pair (J1V846/J1V848). All samples were analyzed for inductively coupled plasma (ICP) metals, IC anions, pesticides, and polycyclic aromatic hydrocarbons. In addition, one equipment blank (J1V849) was collected and analyzed for ICP metals and mercury. SDG JP1000 was submitted for third-party validation. Minor deficiencies are as follows.

In the ICP metals analysis, calcium, chromium, magnesium, nickel, and zinc were detected in the method blank. Due to method blank contamination, third-party validation qualified all calcium, chromium, magnesium, nickel, and zinc results in sample J1V849 as undetected with "UJ" flags. Data are usable for decision-making purposes.

In the ICP metals analysis, the laboratory control sample recovery for silicon was below the project recovery limit at 19%. All silicon results in SDG JP1000 were qualified as estimated with "J" flags by third-party validation. Estimated data are usable for decision-making purposes.

In the ICP metals analysis, the matrix spike (MS) recoveries are out of project acceptance criteria for five analytes (aluminum [1,382%], antimony [52%], iron [296%], manganese [144%], and silicon [16%]). For aluminum, iron, and manganese, the spiking concentration was insignificant compared to the native concentration in the sample from which the MS was prepared. The deficiency in the MS is a reflection of the variability of the native concentration rather than a measure of the recovery from the sample. Antimony and silicon did not have mismatched spike and native concentrations in the MS. All antimony and silicon results for SDG JP1000 were qualified as estimated with "J" flags by third-party validation. Estimated data are usable for decision-making purposes.

Due to the lack of MS, matrix spike duplicate, and laboratory control sample analysis in the pesticide analysis, third-party validation qualified all toxaphene results as estimated with "J" flags. Estimated data are usable for decision-making purposes.

In the pesticide analysis, the MS recovery was below the quality control (QC) limit for endrin aldehyde (49%). Third-party validation qualified all endrin aldehyde results as estimated with "J" flags. Estimated data are usable for decision-making purposes.

In the IC anions by Method 9056 analysis, the holding time for nitrate, nitrite, and orthophosphate is exceeded by more than twice the limit. Nondetected results for these analytes in SDG JP1000 are discussed above in the Major Deficiencies section. Detected results for these analytes may be considered estimated. Nitrate was detected

in all samples; therefore, third-party validation qualified all nitrate results as estimated with "J" flags. Estimated data are usable for decision-making purposes.

FIELD QUALITY ASSURANCE/QUALITY CONTROL

Relative percent difference (RPD) evaluations of main sample(s) versus the laboratory duplicate(s) are routinely performed and reported by the laboratory. Any deficiencies in those calculations are reported by SDG in the previous sections.

Field quality assurance (QA)/QC measures are used to assess potential sources of error and cross contamination of samples that could bias results. Field QA/QC samples listed in the field logbook (WCH 2015) are shown in Table C-1. The main and QA/QC sample results are presented in Appendix B.

Table C-1. Field Quality Assurance/Quality Control Samples.

Sample Area	Main Sample	Duplicate Sample
600-326 excavation	J1V846	J1V848

Field duplicate samples are collected to provide a relative measure of the degree of local heterogeneity in the sampling medium, unlike laboratory duplicates that are used to evaluate precision in the analytical process. The field duplicates are evaluated by computing the RPD of the sample/duplicate pair(s) for each contaminant of concern. Relative percent differences are not calculated for analytes that are not detected in both the main and duplicate sample at more than five times the target detection limit. Relative percent differences of analytes detected at low concentrations (less than five times the detection limit) are not considered to be indicative of the analytical system performance. The calculation brief in Appendix B provides details on duplicate pair evaluation and RPD calculation.

In the duplicate evaluation, the RPD calculated for manganese (66.4%) is below the acceptance criteria of 30%. Elevated RPDs in environmental samples are generally attributed to natural heterogeneities in the sample matrix. There is no indication that the analytical system was operating out of control. The data are usable for decision-making purposes.

A secondary check of the data variability is used when one or both of the samples being evaluated (main and duplicate) is less than five times the target detection limit, including undetected analytes. In these cases, a control limit of ±2 times the target detection limit is used (Appendix B) to indicate that a visual check of the data is required by the reviewer. No sample results required this check. A visual inspection of all of the data is

also performed. No additional major or minor deficiencies are noted. The data are usable for decision-making purposes.

Summary

Limited, random, or sample matrix-specific influenced batch QC issues, such as those discussed above, are a potential for any analysis. The number and types seen in these data sets are within expectations for the matrix types and analyses performed. The DQA review of the 600-326 waste site verification sampling data found that the analytical results are accurate within the standard errors associated with the analytical methods, sampling, and sample handling. The DQA review for the 600-326 waste site concludes that the reviewed data are of the right type, quality, and quantity to support the intended use. The analytical data were found acceptable for decision-making purposes.

The verification sample analytical data are stored in the Environmental Restoration project-specific database prior to being submitted for inclusion in the Hanford Environmental Information System database. The verification sample analytical data are also summarized in Appendix B.

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